

## REMARKS

Claims 1, 2, 4, and 6 to 16, as amended, appear in this application for the Examiner's review and consideration. Claims 13 to 16 have been withdrawn, as being directed to a non-elected invention. Claims 3 and 5 were previously canceled. The specification has been amended to correct a typographical error. The amendments are fully supported by the specification and claims as originally filed. Therefore, there is no issue of new matter. In addition, the amendments to the independent claims add recitations that elaborate on the structure of the presently claimed invention, and, thus, do not affect the scope of the claims. The amendments only further clarify the claimed invention.

Claim 11 stands rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement, for the reasons set forth on page 2 of the Final Office Action.

In response, Applicants submit that the specification, as originally filed, in the paragraph bridging pages 5 and 6, disclosed

Use of silicon carbide is compatible with existing light-water reactors, thermally, chemically and neutronically. New reactor systems, therefore, do not have to be created in order to utilize a fuel containing silicon carbide. The thermal conductivity of silicon carbide is high so that substantial increases in overall fuel thermal conductivity can be achieved with only a small decrease in the density of uranium atoms. As an example, a thermal conductivity of 50 percent is expected for a 10 percent volume loading of silicon carbide.

As will be understood by those skilled in the art, that paragraph of the specification, as filed, is directed to increases in overall fuel thermal conductivity. It would also be understood by those skilled in the art, that the units for thermal conductivity are not percent. Instead, percent is the unit used for a change in thermal conductivity. The units of thermal conductivity are typically given in units of power divided by distance and temperature, such as  $W/(m \times ^\circ C)$ , where W is Watts, m is meters, and  $^\circ C$  is degrees Celsius.

In addition, at page 6, line 1, the present specification states that, with silicon carbide, "substantial increases in overall fuel thermal conductivity can be achieved." The specification, as originally filed, at page 6, lines 3 and 4, then provides an example of such

an increase, i.e., 50 percent for a 10 percent loading of silicon carbide. Those skilled in the art will clearly understand that the statement in the specification, as originally filed, "a thermal conductivity of 50 percent is expected for a 10 percent volume loading of silicon carbide," is a typographical error. Those skilled in the art would understand that the statement at page 6, lines 3 and 4, of the specification means an increase in the thermal conductivity of 50 percent is expected for a 10 percent volume loading of silicon carbide.

This is also clearly demonstrated by the statement at page 3 of the Office Action dated February 9, 2007, that the specification is enabling for increased thermal conductivity of 50 percent for a 10 percent volume loading of silicon carbide. The Examiner understood at that time that page 6, lines 3 and 4, of the specification was describing the increase in the thermal conductivity that was possible with a 10 percent loading of silicon carbide. The specification has been amended accordingly to correct the typographical error.

Therefore, the specification and claims meet the requirements of 35 U.S.C. § 112, first paragraph. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claim 11 under 35 U.S.C. § 112, first paragraph.

Claims 1, 4, 6 to 9, 11, and 12 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over U.S. Patent No. 3,164,487 to Carley-Macaulay et al. (Carley-Macaulay) in view of U.S. Patent No. 3,305,325 to Nicholson et al. (Nicholson) and U.S. Patent No. 4,073,834 to Mysels, for the reasons set forth on page 3 of the Final Office Action;

Claims 2 and 10 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over Carley-Macaulay in view of Nicholson and Mysels, and further in view of U.S. Patent No. 3,129,141 to Burnham et al. (Burnham) and U.S. Patent No. 5,952,046 to Chayka, for the reasons set forth on page 3 of the Final Office Action; and

Claim 11 stands rejected under 35 U.S.C. § 103(a), as being unpatentable over Carley-Macaulay in view of Nicholson and Mysels, and further in view of British Patent Publication No. 1,035,789 (GB'789), for the reasons set forth on page 3 of the Final Office Action.

In response, Applicants submit that the present claims are in condition for allowance for the reasons set forth in the Amendment filed in response to the previous Final Office Actions and for the reasons set forth below. The presently claimed invention is directed to a method to produce uranium dioxide fuel in pellet shape for use in a light water reactor. The claimed method comprises providing an arrangement, comprising porous uranium dioxide. The porous uranium dioxide is infiltrated with a precursor liquid,

and the arrangement, comprising the porous uranium dioxide infiltrated with the precursor liquid, is cured. The arrangement, comprising the porous uranium dioxide, is thermally fired such that the precursor liquid is converted to a second phase. The fired arrangement has a higher thermal conductivity than the arrangement without infiltration of the uranium dioxide with the precursor liquid.

In contrast to the presently claimed invention, Carley-Macaully discloses methods of producing carbon-impregnated artifacts. The carbon-impregnated artifacts are produced by placing an artifact, having high open porosity and low thermal conductivity, in an atmosphere of hydrocarbon gas. While the artifact is in the atmosphere of hydrocarbon gas, an initial zone of the artifact is heated to a temperature at which carbon is deposited from the gas permeating the artifact to impregnate fully the initial zone. The temperature of the impregnated zone is then raised progressively to maintain the temperature within an advancing impregnated/non-impregnated boundary zone, and the rate of the rise in temperature in the initial zone is limited, so that the advancing boundary zone is fully impregnated. Carley-Macaully, column 1, lines 20 to 30.

The process increases the thermal resistance in the impregnated zone. Carley-Macaully, column 1, lines 43 to 46. Therefore, the process disclosed by Carley-Macaully decreases the thermal conductivity of the artifact. Carley-Macaully teaches and claims that desirable properties of the artifact include low thermal conductivity. Carley-Macaully, column 1, lines 31 and 32, and claims 1, 2, 6, 9, and 10.

Applicants submit that all of the claims of Carley-Macaully are directed to methods of preparing a carbon impregnated artifact or nuclear fuel element having low thermal conductivity. Carley-Macaully does not disclose or suggest increasing the thermal conductivity of the disclosed artifacts or fuel elements. One of ordinary skill in the art following the teaching of Carley-Macaully would understand that the thermal conductivity should be kept low, and that the thermal conductivity would be decreased by the disclosed deposition of carbon. One of ordinary skill in the art, following the teaching of Carley-Macaully, would have no reason to modify the disclosed process to increase thermal conductivity of the artifact or fuel element, and, thus, would have no reason to obtain the presently claimed invention.

As will also be understood by those skilled in the art, the only reason one of ordinary skill in the art would introduce carbon into a nuclear fuel with the method

disclosed by Carley-Macaully would be to provide a moderator for the fast neutrons formed in a nuclear reactor from the fission of the nuclei of the fuel atoms. The velocity of fast neutrons must be slowed to that of thermal neutrons for fission of the fuel atoms to occur in most nuclear reactors. Those skilled in the art would clearly understand that replacing the carbon disclosed by Carley-Macaully with a material that increased the thermal conductivity of the fuel would not function properly as a moderator. In addition, silicon is a poorer moderator than carbon, and is also a neutron absorber. One of ordinary skill in the art, following the teaching of Carley-Macaully would not deposit silicon or silicon carbide in or on a nuclear fuel element, as the silicon or silicon carbide would act as a neutron absorber, not a moderator, and would increase thermal conductivity.

Thus, modifying the method disclosed by Carley-Macaully in accordance with the disclosure of the other cited references or in the manner required to obtain the presently claimed invention would render the method disclosed by Carley-Macaully and the resulting artifact unsatisfactory for their intended purposes, and would change the principle of their operation. Such modifications are impermissible for a rejection under 35 U.S.C. § 103(a). A combination of references that requires such modifications is improper, and does not make a *prima facie* case of obviousness.

As stated in M.P.E.P. 2143.01(V), citing *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984),

If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification.

Similarly, M.P.E.P. 2143.01(VI), citing *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959), states

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious.

In addition, the Supreme Court in *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. \_\_\_, 127 S. Ct. 1727, 1740-41 (2007), held that for an obviousness rejection under 35 U.S.C. § 103(a) to stand, the prior art must provide a reason for one of ordinary skill in the art to combine the elements disclosed in cited prior art references to obtain the claimed

invention. Combining the disclosure of Carley-Macaulay with any disclosure that would increase the thermal conductivity of the artifact or fuel element disclosed by Carley-Macaulay is improper, and cannot be used to make a *prima facie* case of obviousness.

Nicholson and Mysels do nothing to overcome the deficiencies of Carley-Macaulay. Nicholson discloses that a refractory body, having an intercommunicating network of pores, can be rendered less porous and more dense by depositing carbon, silicon, or silicon nitride or carbide in the pores of the body.

Mysels discloses that carbon can be deposited in the pores of a fuel element by placing a phenol-formaldehyde prepolymer or furfuryl alcohol monomer/prepolymer into the pores of the fuel element, curing the prepolymer, and then decomposing the cured polymer.

As discussed above, one of ordinary skill in the art, following the teaching of Carley-Macaulay would have no reason to modify the disclosure of Carley-Macaulay by depositing a material into an artifact that increased the thermal conductivity of the artifact. Carley-Macaulay clearly teaches low thermal conductivity artifacts and a method that decreases thermal conductivity.

In addition, those skilled in the art would also understand that Carley-Macaulay deposits carbon to act as a moderator for a nuclear fuel, and that silicon is a neutron absorber that would interfere with nuclear reactions. Therefore, one of ordinary skill in the art combining the disclosures of Carley-Macaulay, Nicholson, and Mysels would deposit carbon, which Carley-Macaulay teaches lowers the thermal conductivity, and is also known to function as a moderator in a nuclear reactor.

Depositing anything other than carbon that raises thermal conductivity, as presently claimed, would render the method disclosed by Carley-Macaulay and the resulting artifact unsatisfactory for their intended purposes, and would change the principle of their operation. One of ordinary skill in the art combining the disclosure of Carley-Macaulay, Nicholson, and Mysels, would not obtain the presently claimed invention. Carley-Macaulay, Nicholson, and Mysels, whether taken alone or in combination, do not disclose or suggest the presently claimed invention.

Therefore, as Carley-Macaulay, Nicholson, and Mysels, whether taken alone or in combination, do not disclose or suggest the presently claimed invention, the present claims are not obvious over those references. Accordingly, it is respectfully requested that the

Examiner withdraw the rejection of claims 1, 4, 6 to 9, 11, and 12 under 35 U.S.C. § 103(a) over Carley-Macaulay, Nicholson, and Mysels.

Burnham and Chayka do nothing to overcome the deficiencies of Carley-Macaulay, Nicholson, and Mysels. As cited in the Final Office Action, Burnham discloses that nuclear reactor fuel has good thermal conductivity. However, as discussed above, Carley-Macaulay teaches that desirable properties include low thermal conductivity. Therefore, Carley-Macaulay teaches away from Burnham, and the combination of those references is improper.

Chayka, as cited by the Final Office Action, discloses that a liquid allylhydridopolycarbosilane is commercially available, and is known in the art as a silicon carbide source. However, as discussed above, the clear teaching of Carley-Macaulay is that desirable properties include low thermal conductivity. In addition, those skilled in the art will understand that Carley-Macaulay discloses the deposition of carbon on a nuclear fuel as a moderator of fast neutrons in a nuclear reactor. Therefore, one of ordinary skill in the art would not modify the disclosure of Carley-Macaulay by depositing the liquid allylhydridopolycarbosilane disclosed by Chayka, as the resulting silicon carbonate would increase thermal conductivity, and, as discussed above, would be absorb neutrons and be a poor moderator. Combining Chayka with Carley-Macaulay would render the method disclosed by Carley-Macaulay and the resulting artifact unsatisfactory for their intended purposes, and would change the principle of their operation. Therefore, the combination of Carley-Macaulay and Chayka is improper.

Therefore, as one of ordinary skill in the art, following the teaching of Carley-Macaulay would not combine the disclosures of that reference with Burnham or Chayka, the claims are not obvious over Carley-Macaulay, Nicholson, Mysels, Burnham, and Chayka. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claims 2 and 10 under 35 U.S.C. § 103(a) over Carley-Macaulay, Nicholson, Mysels, Burnham, and Chayka.

GB'789 does nothing to overcome the deficiencies of Carley-Macaulay, Nicholson, and Mysels. As cited in the Final Office Action, GB'789 discloses that low gas permeability can be obtained by repeating the steps of impregnating, curing, and carbonizing.

As discussed above, Carley-Macaulay teaches that depositing carbon decreases thermal conductivity. In contrast, there presently claimed invention is directed to a method in which the thermal conductivity of an arrangement comprising uranium dioxide

fuel is increased. Therefore, even in one of ordinary skill in the art combined the teachings of Carley-Macaulay, Nicholson, Mysels, and GB'789, the resulting combination would not provide the presently claimed invention. The resulting combination would result in the deposition of carbon into a nuclear fuel element. Carley-Macaulay, Nicholson, Mysels, and GB'789 do not disclose or suggest a process for increasing thermal conductivity, as presently claimed.

As Carley-Macaulay, Nicholson, Mysels, and GB'789 do not disclose or suggest the presently claimed invention, the present claims are not obvious over those references. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claim 11 over Carley-Macaulay, Nicholson, Mysels, and GB'789 under 35 U.S.C. § 103(a).

Applicants thus submit that the entire application is now in condition for allowance, an early notice of which would be appreciated. Should the Examiner not agree with Applicants' position, a personal or telephonic interview is respectfully requested to discuss any remaining issues prior to the issuance of a further Final Office Action or Advisory Action, and to expedite the allowance of the application.

No fee is believed to be due for the filing of this Amendment. Should any fees be due, however, please charge such fees to Deposit Account No. 11-0600.

Respectfully submitted,

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